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linéairement mobiles du côté d'une rangée de cathodes suspendues verticalement et parallèles les unes par rapport aux autres. L'ensemble de bras de décolage est déplacé et aligné automatiquement avec chaque cathode pour ensuite être tourné de façon à ce que les couteaux montés à l'extrémité de l'ensemble de bras de décolage pénètrent entre la plaque de base de la cathode et les feuilles de zinc de chaque côté de la cathode et pèle ensuite les feuilles de zinc de la plaque de base de la cathode. Cela est fait jusqu'à ce que la cathode soit décollée. L'appareil est de préférence fourni avec des roues pour la mobilité.

rack of cathodes suspended vertically in parallel alignment with one another. The single stripping arm assembly is automatically moved and positioned in alignment with each cathode and then pivoted so that the knives mounted at the end of the stripping arm assembly wedge between the cathode base plate and the zinc sheets on each side of the cathode and then proceed to peel or strip the zinc sheets from the cathode base plate. This is done until each cathode is so stripped. The apparatus is preferably provided with wheels for mobility.

METHOD AND APPARATUS FOR AUTOMATED STRIPPING
OF ZINC SHEETS FROM ALUMINUM CATHODE BASE PLATES

BACKGROUND OF THE INVENTION

5 1. Field of the Invention

 This invention relates to a novel method and apparatus
for automated stripping or peeling of electrodeposited zinc
sheets from aluminum cathode base plates. More
particularly, the invention relates to a compact and mobile
10 automated cathode stripping system, particularly suitable
to be used with conventional "small" aluminum cathodes,
although it may also be employed with the "jumbo" or large
sized cathodes, if desired.

2. Brief Description of the Prior Art

15 Applicant's predecessor in title had developed and
patented a cathode stripping system for stripping
electrolytically deposited zinc from cathodes (c.f. U.S.
Patent No. 4,209,379 of June 24, 1980). However, the actual
stripping operation within that system was not automatic
20 and was carried out by hand. Such manual stripping requires
skilled operators and even then it is time consuming and
difficult to perform and control.

 A number of patents describe automated stripping
systems, such as U.S. Patent No. 3,689,396 of September 5,
25 1972 where the cathodes are converged individually to a
stripping station where they are stripped one by one with
a suitable wedge and blade arrangement. This is not a
mobile arrangement and requires that all cathodes from the
entire plant be brought to the stripping station.

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U.S. Patent No. 3,847,779 discloses an automatic apparatus for stripping deposited metal from a cathode plate, wherein the cathode plate is advanced through a plurality of operating stations where consecutively the edge portion of the cathode is exposed, then a preliminary stripping is carried out and finally in the last station a complete separation of the deposited metal from the cathode plate is performed. This is a rather complex system that not only requires bringing the cathode to the various stations, but also the latter must all perform automatically in tandem and if a problem occurs in one of the stations, the whole stripping operation is affected.

Another U.S. Patent No. 4,137,130 of January 30, 1979 mentions the deficiencies of the two above mentioned prior U.S. patents and provides a unitary stripping means made of a wedge adapted to be inserted into a V-shaped groove on the side of the metal plate and a blade to propagate the separation of zinc layers. It is also stated in this patent that a plurality of cathode plates may be supported and simultaneously stripped by pairs of the above mentioned unitary stripping means. This system, however, has the disadvantage that, in order to strip a plurality of cathode plates, it requires a great number of stripping means which all must be maintained in good operating condition, which, in practice, is often difficult to achieve. A similar system with a plurality of stripper assemblies is disclosed in U.S. Patent No. 4,131,531 of December 26, 1978.

In U.S. Patent No. 4,304,650 of December 8, 1981 a stripping apparatus is disclosed in which stripping means, provided in pairs to strip each side of the cathode base plate, act from the side of suspended cathodes in a swinging movement, in order to strip the electrodeposited zinc sheets from the cathode plates. Again, however, a plurality of such pairs of stripping means are provided, one for each cathode to be stripped, making such a system complex and difficult to maintain in good working order.

U.S. Patent No. 4,806,213 of February 21, 1989 discloses a method and apparatus for stripping electrodeposited metal precipitate from a supporting structure above the cathode by wedging a specially designed peeling blade between the precipitate and the cathode metal plate. This requires a special supporting structure for the cathodes within a stripping station, so as to liberate the top edge of the cathode for the stripping operation.

Also, U.S. patent No. 5,269,897 of December 14, 1993 describes an installation with a number of zones, such as cathode storage zone, zinc scraping zone, zinc removal zone and so on. This again is a fixed-base stripping installation into which all cathodes must be conveyed.

Other methods for stripping zinc from cathode have also been proposed. For example in Canadian Patent No. 978,895 issued January 27, 1976 this is done hydraulically by using jets of water which penetrate between zinc sheets and the cathode plates and thereby separate one from the other; Canadian Patent No. 1,016,497 issued August 30, 1977

provides for reciprocal flexing of cathode plates to loosen the zinc sheets before stripping the same; and Canadian Patent No. 1,184,878 uses suction-cups to separate the electrolytic deposit from both sides of the cathode.

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OBJECTS AND SUMMARY OF THE INVENTION

It is an object of the present invention to obviate the disadvantages and/or complexities of the systems mentioned above and to provide a simple, automated method and apparatus for stripping zinc sheets from aluminum cathode base plates.

Another object of the present invention is to provide an automated method and machine that can be readily used in existing cellhouses so that such cellhouses may experience the gains in productivity, the reduction in labour costs and the reduction in physically difficult tasks that follow from the mechanization of the zinc-stripping process.

A still further object is to provide a mobile system that may be moved to any desired area of the cellhouse so as to further facilitate the stripping operation.

Other objects and advantages of this invention will be apparent from the following more detailed description thereof.

It is generally believed in the electrolytic zinc industry that the conversion of a conventional (Jepñson design) cellhouse from the manual to the mechanical stripping of zinc from the aluminum cathode base plates is economically borderline because of the extensive structural

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modifications required in the cellhouse in order to accommodate the feed and discharge operations of a fixed-base stripping machine. Moveable stripping machines which can be transferred between cell-rows are therefore to be preferred when the conversion of a cellhouse is considered; these machines are usually constructed with multiple stripping knives so as to strip simultaneously one-half of the cathodes available from each electrolytic cell. An example of such a mobile, multiple head, stripping machine is disclosed in U.S. Patent No. 4,131,531 already mentioned above.

In a conventional electrolytic zinc plant, 40 planar rectangular aluminum cathodes, each having approximately one square metre of plating surface per side, are placed vertically in each electrolytic cell. The upper edge of each cathode is fitted with a supporting headbar and the two vertical edges are covered with "clip on" dielectric edge strips in order to prevent the deposition of zinc around the edges of the cathode. During electrolysis, zinc is deposited on the free faces of the aluminum cathode up to the level of the solution in the electrolytic cell. At the end of the electrolysis period, half-cell groups of zinc-covered cathodes (typically 20) are simultaneously removed from the cell and then are manually stripped on an individual basis; this is obviously an extremely inefficient, as well as very labour intensive, task. Partial mechanization of the stripping process has been accomplished by a system such as disclosed in U.S. Patent

No. 4,209,379 whereby a mobile module is provided suitable for receiving, washing, conveying and stacking stripped cathode sheets. However, fully-mechanized stripping of zinc from the small-sized cathodes normally found in conventional cellhouses has until now proven to be unsatisfactory. For example, there is presently no apparatus which is mobile, which accepts a rack of multiple cathode plates and then strips them sequentially using a single movable stripping means. Instead the trend in the zinc industry has been towards the more expensive alternative of the construction of entirely new cellhouses which employ "jumbo" or large-sized cathodes of approximately two square metres of plating surface per side and for which fully mechanized stripping systems are available using fixed-based stripping machines.

The prior art of automated mechanical stripping of zinc sheets from aluminum cathodes does refer to various apparatus which may be either fixed in position or mobile and are designed to accept a rack of multiple cathode plates which are stripped simultaneously [e.g. U.S. Patent No. 4,304,650 (fixed) and U.S. Patent No. 4,131,531 (mobile)].

The costly and time consuming maintenance of multiple mechanically-complex stripping head-mechanisms is of considerable disadvantage as is the necessity to maintain exact alignment of the multiple heads, in order to prevent damage to the aluminum cathode plates as the stripping heads are advanced across them. The present invention

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obviates such disadvantages of the prior art. The complex and, of necessity, physically large feed and/or discharge conveying systems required by the prior art equipment can also be obviated and the residual conveying needs of the present invention are simplified to the extent that mobile equipment becomes practical.

The design philosophy of the present invention is to reduce the labour requirement of the zinc stripping operation to a minimum, to increase productivity by automating the stripping operation and to minimize the number of aluminum cathodes physically damaged during the stripping operation. The use of a single moveable stripping arm assembly, rather than conveying the cathodes to a fixed-position stripping station, considerably reduces the amount of cathode sway and therefore of stripping-knife damage to the aluminum cathode plates. The correct and repeatable positioning of the stripping arm assembly, achieved by the use of a linear actuator drive, means that the stripping machine normally runs under automatic control and no machine-operator is needed. The only personnel requirement is for a single operator to load and unload cathode racks on the supporting frame provided with the so called "stripping table" for suspending the cathodes and even this operator position could be eliminated if modern high precision automated overhead cranes were used to move the cathode racks about the cellhouse.

In essence the apparatus of the present invention, for automated stripping or peeling of electrodeposited zinc sheets from aluminum cathode base plates, comprises:

(a) an elongated supporting frame at an upper area of which means are provided for supporting headbars of a plurality of cathodes so that said cathodes hang vertically in parallel alignment with one another, said cathodes comprising the aluminum cathode base plates with the zinc sheets electrodeposited on each side thereof;

(b) a stripping mechanism comprising a carriage framework mounted for linear movement at a side of said elongated supporting frame, said stripping mechanism comprising a single pivotable stripping arm assembly carried by said carriage framework and having a pair of guide arms separated by a gap of sufficient width to allow each cathode base plate to penetrate into said gap, and at the outer free ends of said guide arms there is provided a pair of stripping knives with blades capable of wedging between said cathode base plate and said zinc sheets on each side of the cathode when the stripping arm assembly is swung towards and meets a side edge of the cathode with each knife thereafter penetrating between the cathode base plate and the zinc sheet on each side of the cathode;

(c) means for linearly moving said carriage framework along the side of said elongated supporting frame and for automatically stopping said carriage framework and positioning said stripping arm assembly in alignment with each successive cathode;

(d) means for automatically pivoting said stripping arm assembly at each stop of the carriage framework from an initial, generally vertical, position towards an upper

portion of the side edge of the cathode, so that the blades of the stripping knives wedge between the cathode base plate and the zinc sheets when said blades come in contact with the cathode, and for continuing the pivoting of said arm assembly until the zinc sheets are separated from the cathode base plate and fall by gravity to a bottom area of the elongated supporting frame, and then for returning said arm assembly to its original position; and

(e) means at the bottom area of the supporting frame for removing the zinc sheets that have fallen after separation from the cathode base plates.

In a preferred embodiment of the present invention the apparatus is wheeled for mobility. For this purpose it is provided with corner mounted wheels at least one pair of which are steerable, for example by hydraulic means. In fact all moving parts of the apparatus, with the exception of the carriage framework moving, stopping and positioning means are preferably hydraulically operated, although it should be understood that electrical and pneumatic operations are also possible. The automatic moving, stopping and positioning mechanism achieved by the use of a linear actuator drive, whereby the stripping arm assembly is properly positioned at each successive cathode, must, however, be quite precise and for this reason it will normally be electrical with a PLC control. The PLC or program logic controller is provided with a suitable panel for the automatic operations performed by the stripping mechanism. The design and development of such PLC controls is well known in the art.

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The upper end of the elongated supporting frame or the so called "stripping table" is provided with evenly spaced cathode receiving slots situated between parallel horizontal support members or as they are also called "table arms" of the stripping unit. The cathodes are then side-loaded into these evenly spaced slots and hang vertically therefrom in a predetermined parallel alignment with one another. In operation, the mobile stripping apparatus is normally positioned at the end of a row of electrolytic cells and one-half of an electrolytic cell load of cathode plates (normally 20 cathodes) is removed by the operator and simultaneously side-loaded into the evenly spaced cathode receiving slots. The cathodes so loaded alternate with empty cathode receiving slots which are positioned to receive cathodes from the other half cell. This provides sufficient space between the cathodes for penetration of the pair of guide arms during the stripping operation.

When the rack of cathodes has been loaded as mentioned above, a further supporting device will normally be provided as part of the means that support the cathode headbars. This device consists of a horizontally mounted tube, or cathode support barrier and it is raised from its rest position at the base of the stripping unit to an operating position so as to support the bottom of one end of the cathode headbars. There are several alternative embodiments for the direction of travel or the cathode support barrier. In the preferred embodiment, which

prevents the jamming of incompletely loaded cathodes in the cathode-receiving slots, the cathode support barrier is pulled by a wire rope vertically upward in its guide-track, passing in front of the rack of cathodes, to a point some
5 three quarters of the height of the cathodes; the guide-track then makes a shallow turn toward the cathodes to lie some 20° to 30° from the vertical until further upward progress of the cathode support barrier is halted by a limit-switch and a mechanical stop. In another alternate
10 embodiment, the cathode support barrier may be raised in a straight line, the guide-track sloping about 5° from the vertical towards the cathodes, directly from its rest position to its operating position. The cathode support barrier has a horizontal upper surface and an adjacent
15 vertical side of width somewhat less than the distance between the bottom of the cathode headbar and the top of a dielectric edge-strip normally provided on the cathode. The other end of each cathode headbar is supported above the level of the stripping table by a continuous horizontal
20 metal bar, one edge of which is coincident with the end of the cathode-receiving slots, located on top of the rear end of the stripping table. When the cathode support barrier is in its operating position, it lifts one end of the headbar slightly and also provides a bearing surface for the edge
25 of the cathode plate against the forward pressure of the stripping knives.

In order to protect the aluminum cathode edges and/or dielectric edge-strips or edge plates, when such are

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provided on the cathodes, from mechanical damage during loading of the cathode rack, the cathode receiving slots between the table arms of the stripping table should be of such a length that when the cathode support barrier is in place there is a slight play between the edge of the cathode and the end of the cathode receiving slot. In a preferred embodiment, there is also a linear bar of a resilient plastic material, placed across the ends of the cathode receiving slots and on the underside of the stripping table, which projects slightly over the ends of the cathode receiving slots and acts as a cushion for the edges of the cathode and/or dielectric edge or plate during loading of the cathode rack.

Furthermore, in order to limit the tendency of the cathode to sway sideways, an anti-sway brush may be installed at the rear bottom end of the elongated supporting frame. The brush may be a continuous bar mounted, for example, at a 30° downward angle and has sufficiently long stiff bristles, for instance polypropylene bristles, so that when the cathodes are loaded onto the receiving slots of the stripping table and the cathode support barrier is in the operating position, the rearward bottom corner of the cathodes is forced into the bristles of the brush thereby preventing said cathodes from swaying.

The carriage framework of the stripping mechanism may also carry an anti-sway device consisting, for example, of a hydraulic arm mounted horizontally and positioned about

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half way down the length of the cathode. This device advances to contact and hold in place the cathode next ahead of the cathode actually being stripped. It is intended to reduce sideways sway in the cathode next ahead of that being stripped caused by one of the zinc sheets from the cathode being stripped falling against it and pushing it sideways. Such swaying, if permitted, may cause a positioning error of stripping arm assembly at the cathode which is next ahead of the cathode being stripped.

The pivotable stripping arm assembly is normally centrally mounted within the carriage framework and preferably comprises mirror-image paired set of guide arms with a gap in between and joined at their base by a common gearbox. The paired, opposing, stripping knives located at the free ends of the guide arms are also preferably mirror-images of each other and are mounted onto the outer ends of said guide arms so as to rotate tangentially outwardly with limited freedom. The means of actuation of rotation for the knives and the stripping arm assembly comprise a hydraulic cylinder and an offset cam; however, it will be understood that a hydraulic rotary actuator, or pneumatic or electric actuators could be equally effective in this application. The radius of curvature of the blades of the stripping knives is preferably the same as that of the profile of the dielectric area at the upper corner of the cathode plate when such dielectric area is provided and the radius of rotation or tilting of the stripping arm assembly is such that the knife blades correctly strike the dielectric area

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and continue in a downwards arc to intersect the central area of the base plate of the cathode. The paired stripping arms are spaced apart such that, when they are rotated in the vertical plane, each arm passes on the opposite side of the cathode plate being stripped. The angle of rotation in the vertical plane of the stripping arm assembly is closely coupled with the degree of opening (i.e. amount of individual rotation) of the opposing stripping knives. At the start of the stripping motion the knives are fully sprung apart, at an angle of about 60° to each other. After the stripping arm assembly has rotated through a preset arc, the knives are rotated to close so as barely to touch the surface of the dielectric area. The stripping arm assembly is then rotated through a further small arc, until the edge of the knife blades is a few millimeters beyond the edge of the dielectric area whereupon the knives are programmed to spread strongly apart, away from the surface of the aluminum cathode base plate and pushing the zinc sheets outwardly with them. The stripping arm assembly rotates back to its original rest position as soon as the stripped zinc sheets fall through a photoelectric detector beam, and the carriage then advances the stripping arm assembly into position to strip the next cathode. The photoelectric detector beam is located beneath the bottom of the aluminum cathodes when they are resting on the table arms of the stripping machine; it detects the fall of each pair of stripped zinc sheets and sends a signal to the linear actuator to advance the stripping arm assembly t

the next cathode. If it does not detect the fall of any zinc sheets, as a result of incomplete stripping, the stripping knives will cycle a number of times in an attempt to strip the zinc sheets before the carriage advances the arm assembly to the next cathode.

The carriage framework will also usually be provided with a washing device which normally comprises two jet spray heads mounted on individual hydraulically-extensible rods, which are located just above the height of the top of the zinc sheets on the cathode, and which are long enough to reach horizontally across the full width of the cathode. Each spray head may consist of a square end-fitting with two jets mounted on either side, an upper full-jet pair set to spray horizontally and a lower pair mounted to spray veejet sprays at 45° downward angles. The heads are so positioned on the carriage that, when extended, they penetrate between the two cathodes which are located in front of the cathode being stripped in order to wash the zinc sheets, and the two cathodes which are located behind the cathode being stripped, in order to wash any residual acid electrolyte from the aluminum cathode plates.

Wash

The stripping arm assembly, the cathode-washing device and an anti-sway device are mounted on the carriage framework which is connected to and driven by a linear actuator drive capable of accurately positioning the carriage and the stripping arm assembly at each successive cathode. In the preferred embodiment this is accomplished via a 4800 mm long, electrically driven, linear-actuator

module with toothed belt drive. The carriage is supported, but not driven, by two additional bearing-block tracks situated above and below the linear actuator. The carriage and the stripping arm assembly normally advances in one direction only (usually from right to left, in terms of a person facing the open side of the table-arm loading-rack) and automatically retreats back to its starting point when it has completed the stripping of a one-half cell load of cathodes.

At the bottom of the elongated supporting frame there is normally provided a chain-drive stripping conveyor within a U-shaped trough onto which the stripped zinc sheets fall by gravity and which moves them out of the stripping machine. Usually it will move them to a stacking conveyor which stacks the zinc sheets in a receiving bin, fitted with hydraulically actuated stop-gates and a bottom-mounted load-out chain conveyor which accepts stripped zinc sheets from the stacking conveyor until a photoelectric detector senses that the bin is full. At that point, the stop-gates open and the stack of zinc sheets is advanced on the load-out conveyor to a walking-beam transfer point which has provision for the temporarily storage of a limited number of such stacks of zinc sheets while they await pick-up by fork-lift truck or the like.

The invention also includes a method of automated stripping or peeling of electrodeposited zinc sheets from aluminum cathode base plates, which comprises:

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(a) suspending on an elongated supporting frame a plurality of cathodes so that they hang vertically in parallel alignment with one another, said cathodes comprising the aluminum cathode base plates with zinc sheets electrodeposited on each side thereof;

(b) providing a stripping mechanism comprising a carriage framework mounted on a side of said elongated supporting frame, said carriage framework being movable along a lateral line beside said elongated supporting frame, said stripping mechanism also comprising a single stripping arm assembly carried by said carriage framework and having a pair of guide arms separated by a gap of sufficient width to allow each cathode base plate to penetrate into said gap and having, at the outer free ends of said guide arms a pair of stripping knives with blades capable of wedging between said cathode base plate and said zinc sheets deposited on each side thereof, when said stripping arm assembly is swung towards and meets a side edge of said cathode;

(c) moving said carriage framework linearly along said lateral line and automatically stopping and positioning the single arm assembly at each successive cathode so that the it is aligned successively with each cathode;

(d) upon such positioning automatically pivoting said stripping arm assembly from an original substantially vertical position towards an upper portion of the side edge of the cathode so that the blades of the stripping knives

wedge between the cathode base plate and the zinc sheets on each side of the cathode when they come in contact with said side edge;

5 (e) stripping said zinc sheets from said cathode base plate by continuing the pivoting movement of said arm assembly with the cathode base plate penetrating into the gap between the guide arms, until the metal sheets are separated from said cathode base plate, and then returning said stripping arm assembly to its original position; and

10 (f) automatically continuing the stripping operation until substantially each cathode suspended on said elongated supporting frame has been so stripped.

It should be mentioned that the automatic stopping, positioning and stripping operation in accordance with the
15 present invention is normally controlled by a programmable logic controller or PLC which is provided with a suitable panel for the required automatic operations as is well known in the art. One of these operations would normally require to swing or pivot the stripping arm assembly two or three
20 times in secession if the first time it does not strip the zinc sheets from the cathode base plate. However, if even after two or three such attempts the zinc sheets cannot be stripped, the stripping mechanism is so programmed as to allow such cathode to remain unstripped and proceed to the
25 next cathode, rather than to stop the whole stripping operation. In practice only a small percentage of such unstripped cathodes is present (about 1%) due to an excessively strong attachment of the zinc sheets to the aluminum cathode base plates.

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It should also be noted that when reference is made herein to aluminum cathode base plates, this is meant that the base plates are primarily made of aluminum as is well known in the art and, of course, this includes many aluminum alloys that are suitable for such purposes. Furthermore, the edge of the aluminum cathode base plate where the stripping knives wedge between the cathode base plate and the electrodeposited zinc sheets is preferably provided with a dielectric area to facilitate such wedging. This dielectric area is normally provided at an upper edge portion of the cathode base plate, usually at the solution line level. In addition, both edges of the aluminum cathode base plates are normally provided with dielectric edge-strips so as to prevent electrodeposition of zinc at such edges. This is well known in the art.

Moreover, in accordance with the present invention it is preferable to provide a mirror-image paired set of guide arms and mirror-image paired stripping knives at the free ends thereof. It is also advantageous to provide said stripping knives with blades having a curvature that matches the dielectric area profile or curvature where the blades meet said profile; this enhances the ability to wedge between the zinc sheets and the cathode base plates in that spot without damaging the aluminum cathode base plates.

The pivoting of the stripping arm assembly should also be carried out with a radius of rotation such that the knife blades correctly strike the dielectric area of the

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cathode base plate and upon wedging between the zinc sheets and the cathode base plate continue in a downward arc so as to intersect the central area of the cathode base plate. After wedging between the cathode base plate and the zinc sheets, the stripping knives may be spread apart to facilitate the stripping operation.

Finally, it is advantageous to spray-wash the cathodes prior to stripping the zinc sheets and to spray-wash the stripped cathode base plate after peeling of the zinc sheets to remove any residual acid electrolyte therefrom.

Once the zinc sheets have been stripped as described above, they will fall by gravity on a suitable conveyor and will be conveyed to an appropriate stacking and storage areas.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will further be described with reference to the accompanying drawings in which:

Fig. 1 is a side view of the entire system comprising the stripping apparatus (without the stripping mechanism), a stacking conveyor, a load-out conveyor and a receiving bin for stacks of zinc sheets;

Fig. 2 is an end view of the stripping apparatus of the present invention including the stripping mechanism;

Fig. 3 is a back view of the stripping mechanism, including its carriage framework;

Fig. 4 is a view in perspective of the stripping mechanism of the present invention;

Fig. 5 is a top view of the stripping arm assembly of the present invention;

Fig. 6 is a side view of the stripping arm assembly of the present invention;

5 Fig. 7 is a front view A-A of the stripping knives arrangement on the stripping arm assembly shown in Fig. 6;

Fig. 8 is a view showing the stripping arm assembly in operation; and

10 Fig. 9 is a perspective view of the elongated supporting frame for hanging cathodes, including a conveyor at its bottom for removing zinc sheets after stripping.

DESCRIPTION OF THE PREFERRED EMBODIMENT

15 The entire system as illustrated in Fig. 1 shows the automatic zinc stripping apparatus 10 of the present invention (without the stripping mechanism) combined with a stacking conveyor 12, a load-out conveyor 14 and a receiving bin 16 for stacks of zinc sheets. It should be noted that the same reference numbers are used when
20 referring to the same elements in all figures.

25 In the apparatus 10, the upper two-dimensional steel framework 18 supports motor 20 which powers the raising and lowering of cathode support barrier 22 in its guide tracks 24 using a wire rope wound around a pair of take-off reels 23 connected by a shaft 25.

A rectangular, box-shaped, elongated supporting framework 26 is also contained within the apparatus 10 and at its upper end there are provided means 28 capable of

supporting headbars of a plurality of cathodes 30. These means 28 normally consist of a plurality of bars 32 (see Fig. 4 and Fig. 9) with side ribs 35 at their bottom, which bars 32 are mounted in parallel to each other across the width of the elongated framework 26 and have small slots in-between for insertion of the cathodes so that headbars 34 rest on the ribs 35 when the cathodes 30 are suspended. In the trade this is usually called a "stripping table".

For the embodiment for use in Jephson cellhouses, there are forty one bars 32, which are also called "table arms", cut into the flat stripping base-plate. These arms are an integral part of the base-plate and are supported along their length by screwed-on structural support ribs 35 which are welded to a rear steel mounting plate 33 which itself is firmly attached to the main chassis member of the steel framework 18. The support ribs 35 (see Fig. 4 and Fig. 9) are of sufficient depth (e.g. 50 mm) to support the weight of a full rack of cathodes 30 along the length of the stripping table and the cut-out slots between the ribs 35 are of sufficient size to permit the passage of the spacer bar 31 (see Fig. 9) provided just below the headbar 34 which thereby rests on said ribs 35. The cathode headbar supporting spacer bar 31 runs the full width of the stripping table and the table arms are separated by the cathode receiving slots which flare open by some 30° at their outer ends in order to more easily guide the rack of cathodes during the loading operation.

The support barrier 22 is in its rest position at the bottom of the supporting frame as shown in Fig. 9. However, once all the cathodes 30 have been loaded onto the stripping table, the support barrier 22 is raised in guide tracks 24 to its operating position as shown in Fig. 1. In this position the support barrier 22 lifts one end of the headbars 34 slightly and also provides a bearing surface for the upper portion of the cathodes 30 when stripping is performed.

In Fig. 1 and Fig. 9 the stripping conveyor 36 is shown with chains 36a and 36b to remove the zinc sheets 38 which fall thereon (see Fig. 8). The zinc sheets are conveyed out of the stripping apparatus 10 and onto the stacking conveyor 12. The stripping conveyor 36 is mounted at the bottom of a U-shaped trough 39 which helps to keep the fallen zinc sheets 38 in proper position for removal. If a "sticky" zinc sheet is not peeled after two or three attempts by the stripping mechanism, this will be detected by a photoelectric beam detector 41 within the trough 39 (see Fig. 9) which detects the fall of stripped zinc sheets onto the stripping conveyor, and the stripping mechanism will then move forward leaving the "sticky" zinc sheet unpeeled.

Referring to Fig. 1 and Fig. 2, the upper two-dimensional framework 18 also comprises mounting brackets 17 for a linear actuator module 19 for driving the stripping mechanism carriage framework 21, and further comprises supporting beams 27a and 27b for providing two

rear mounted stripping head carriage-supporting bearing-block tracks 29a and 29b.

5 To provide mobility, the entire apparatus 10 is mounted on wheels 40, 42. There are four such wheels and they are individually hydraulically powered. The wheels are steerable via individual hydraulic cylinder and piston sets.

10 Referring to Fig. 2 and Fig. 3 in particular, the stripping mechanism carriage framework 21 is driven by the linear-actuator module 19 attached to the upper steel framework 18. The linear-actuator module 19 is supplied with an integral flat-topped drive block to which there is attached a bracket 44 by means of two pins 46a, 46b which serve to connect the linear actuator 19 to the carriage framework 21 by way of plate 48 welded about the centre line of a main support beam 50 of the carriage framework 21. Obviously, other attachment means may be used, but the advantage of the pin connection is that while it is mechanically stable, it provides for a quick disconnect of the carriage if this is necessary for maintenance.

20 The carriage framework 21 is supported on the upper steel framework 18 by a pair of welded-on bearing-block tracks 29a, 29b situated above and below the linear-actuator 19. These tracks are equipped with horizontally keyed attachment blocks which are fitted with receiving blocks 52 bolted to plates 54 which are welded to the carriage framework 21.

As shown in Fig. 2 and Fig. 4, the lower portion of the carriage framework 21 projects downwardly at an angle so that its bottom end penetrates into the cathode supporting frame 26 and is positioned near the suspended cathodes 30. A single, pivotable stripping arm assembly 56 is centrally mounted on a pivot 58 at the bottom of the carriage framework 21. The stripping arm assembly 56 comprises a pair of guide arms 56a and 56b as particularly well shown in Fig. 5. They are joined together by a common gearbox 60. The gearbox 60 contains two circular spur gears 62, powered by a hydraulic cylinder 64 with an offset cam. A lubricating fitting 66 is provided for lubrication of the gearbox 60. The spur gears 62 are connected to and drive knife shafts 68, and thus operate knives 70a and 70b of the knife assembly 70. Between guide arms 56a and 56b a gap 57 is provided which is wide enough to allow penetration of the cathode base plate thereinto when the stripping operation is carried out.

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stripper

The knife assembly 70 is shown in detail in Fig. 7 which is a view along line A-A of Fig. 6. Here the knives 70a and 70b are shown in their closed position in solid lines and in their open or spread-out position in broken lines. The body of the knife assembly 70 incorporates a keyway 72 in a hole which accepts the knife shaft 68 so that each knife may be firmly aligned with the knife shaft. The body of the knife also incorporates a stop block 74 which, in conjunction with setting screws 76, limits the arc of travel of each knife 70a, 70b to a desired degree of

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rotation (e.g. 30°) and permits a very accurate positioning of the knife blades 71a, 71b at the edge of the cathode 30. When the cathode 30 comprises a dielectric surface 89 as shown in Fig. 2, the knife blades 71a, 71b accurately strike said dielectric surface 89 and then penetrate between the zinc sheets 38 and the cathode base plate 37 (see Fig. 8) whereafter they spread apart to facilitate stripping of the zinc sheets 38 from the base plate 37. The radius of curvature 71 of the knife blades (see Fig. 6) is preferably the same as the profile of the dielectric surface 89 where said blade wedges between the zinc sheets and the cathode base plate.

*heads
away*

The stripping mechanism of the present invention operates automatically. The carriage framework 21 is driven by the linear actuator 19 which is electrically operated so that the stripping arm assembly 56 automatically stops at each cathode 30 and is positioned so that the gap 57 is in alignment with each said cathode. Then, the arm assembly 56 is tilted as shown in Fig. 2 and Fig. 8 with the knives 56a and 56b spreading apart when the knife blades 71a and 71b have penetrated between the zinc sheets 38 and the cathode base plate 37 and once the stripping operation is completed, the stripping arm assembly 56 returns to its initial essentially vertical position as shown particularly in Fig. 4. The automatic control of the operation is provided by means of a PLC which may be located in any desired place. In Fig. 1 it is shown at 45. Also an on/off control 47 is provided so as to shut off the machine or re-start it at any desired moment.

*tilted
stripper*

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In order to facilitate the proper automatic positioning of the arm assembly at each cathode, it is preferable that the cathode which is just ahead of the one being stripped, be in a straight position. Normally the stripping proceeds from right to left when looking at the apparatus 10 in Fig. 1. In order to maintain such cathode straight (see cathode 30a in Fig. 8), an arm 83 is provided on the carriage framework 21, ahead of the arm assembly 56, which arm 83 is lowered simultaneously with the arm assembly 56 and holds the cathode just ahead of the cathode being stripped in a straight position despite the pressure being exerted thereon by the falling zinc sheet 38. This can be particularly well seen in Fig. 8 where the cathode 30a which is just ahead of the one being stripped is straight, while the cathode base plate 37a which is just behind of the cathode being stripped has been tilted by the falling zinc sheet 38. Furthermore, a brush 85 with long bristles may be provided at the rear lower corner of the cathodes 30 to prevent them from swaying.

Moreover, washing devices are provided within the stripping mechanism to spray-wash the surfaces of the two cathodes just in front of the one being stripped and the surfaces of the two cathode base plates just behind the cathode being stripped. This is done by means of spray heads 80 which are symmetrically mounted on each side of the stripping arm assembly 56. Each head 80 is connected to a hydraulic cylinder and piston 82 which has sufficient stroke to advance the washing head 80 across the full width

Brush

clean?

of a cathode. On each washing head 80 there is an upper pair of full-jet nozzles, set to spray horizontally at a level just above the top of the zinc sheet on the cathode, and a lower pair of veejet nozzles set to spray at a downward angle of 45°. Water under pressure is provided via extensible hoses 84.

As shown in Fig. 1, once the zinc sheets have been stripped or peeled as described above, they are conveyed by the stripping conveyor 36 out of the apparatus 10 and into the stacking conveyor 12. Fig. 1 shows the stacking conveyor 12 in two outlines, namely in its fully raised position when the receiving bin 16 is full, shown in solid lines, and in its lowered position when the receiving bin 16 is empty, shown in broken lines. The stacking conveyor 12 comprises conveyor chains 11 contained within a U-shaped trough 13 which is adjustable in height via a hydraulic piston-cylinder 15 that is normally controlled by a photoelectric detector which measures the zinc-sheet stack in the receiving bin 16 of the load-out conveyor 14. Both the stacking conveyor chains 11 and the stripping conveyor chains 36a, 36b may be driven by the same hydraulic motor so that the two chain conveyors travel at the same rate of speed.

When the zinc sheets arrive at the take-up sprocket end of the stacking conveyor 12, they pass between two ejector rolls 43, 45. The lower and wider ejector roll 43 is driven at twice the speed of the stacking conveyor chains 11. The upper heavy-steel guide roll 45 is free

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floating on supporting arms 47 which are hinged at pivots 49 on the frame of the stacking conveyor trough 13. In this manner the ejected zinc sheets fall in smooth arcs into the load-out conveyor 14 of the receiving bin 16 to be stopped by stop doors 51. The stacking conveyor is directly connected to the stripping machine 10 by a pin connection 53 which is free to rotate vertically, but not horizontally and is supported by two small castor-type wheels 55 located at the output end of the conveyor, which are free to swivel, but are not powered.

The load-out conveyor chains 87 are connected with an open structural framework 59 which comprises a side-walled load-out conveyor receiving bin 61 and the open sided bundle storage area 63 of sufficient size to accept at least two bundles of zinc sheets. When a photoelectric detector signals that the receiving bin 61 is full, the stop-doors 51 at the far end of the bin are opened by a hydraulic cylinder and piston 65 and the bundle of zinc sheets is carried forward on the load-out conveyor 87 to rest on support-feet 67 of a walking beam 69 which is driven by hydraulic pistons and cylinders 73 and offset cams 75. The walking beam advances the bundle 77 of zinc sheets into position in the bundle storage area 63 for fork-lift pick-up as is shown in broken lines in Fig. 1. The chain conveyor 87 is powered by a hydraulic motor 79 and the entire unit 16 rests on four swivelable unpowered castors 81.

It should, of course, be understood that the preferred embodiment described above is in no way limitative and many modifications obvious to those skilled in the art can be made therein without departing from the spirit and scope of
5 this invention.

CLAIMS

1. Apparatus for automated stripping of electrodeposited zinc sheets from aluminum cathode base plates comprising:

5 (a) an elongated supporting frame at an upper area of which means are provided for supporting headbars of a plurality of cathodes so that said cathodes hang vertically in parallel alignment with one another, said cathodes comprising the aluminum cathode base plates with the zinc
10 sheets electrodeposited on each side thereof;

(b) a stripping mechanism comprising a carriage framework mounted for linear movement at one side of said elongated supporting frame, said stripping mechanism comprising a single pivotable stripping arm assembly
15 carried by said carriage framework, said stripping arm assembly having a pair of guide arms separated by a gap of sufficient width to allow each cathode base plate to penetrate into said gap, and having, at the outer free ends of said guide arms, a pair of stripping knives with blades
20 capable of wedging between said cathode base plate and said zinc sheets on each side of the cathode when the stripping arm assembly is swung towards and meets a side edge of the cathode, with each knife thereafter penetrating between the cathode base plate and the zinc sheet on each side of the
25 cathode;

(c) means for linearly moving said carriage framework along the side of said elongated supporting frame and for automatically stopping said carriage framework and

positioning said stripping arm assembly in alignment with each successive cathode;

(d) means for automatically pivoting said stripping arm assembly at each stop of the carriage framework towards an upper portion of the side edge of the cathode, so that the blades of the stripping knives wedge between the cathode base plate and the zinc sheets when said blades come in contact with the cathode, and for continuing the pivoting of said stripping arm assembly until the zinc sheets are separated from the cathode base plate and fall by gravity to a bottom area of the elongated supporting frame, and then for returning said arm assembly to its original position; and

(e) means at the bottom area of the supporting frame for removing the zinc sheets that have fallen after separation from the cathode base plates.

2. Apparatus according to claim 1, wherein the means for supporting headbars of a plurality of cathodes comprise a stripping table with evenly spaced cathode receiving slots situated between parallel table arms, allowing the cathodes to be side-loaded into the evenly spaced slots and to hang vertically from said stripping table in parallel alignment with one another.

3. Apparatus according to claim 2, wherein a horizontally mounted cathode support barrier is further provided to support the cathode headbars once the cathodes are suspended on the stripping table, said cathode support barrier being movable from a rest position at the base of

the elongated supporting frame to an operating position under the ends of the cathode headbars at the opposite side of the elongated supporting frame to the side where the stripping mechanism is mounted.

5 4. Apparatus according to claim 3, wherein an anti-sway brush is installed having long and stiff bristles, so that when the cathodes are loaded onto the stripping table and the support barrier is in the operating position, a bottom corner of the cathodes is forced into the bristles
10 of the brush, thereby preventing said cathodes from swaying.

 5. Apparatus according to claim 1, wherein the stripping arm assembly is centrally mounted on a pivot within the carriage framework and comprises a mirror-image
15 paired set of guide arms with the gap in-between, said set of guide arms being joined at their base by a common gearbox and at their free ends being provided with a pair of mirror-image set of knives each mounted onto the outer end of each guide arm.

20 6. Apparatus according to claim 5, wherein the carriage framework further supports a hydraulic cylinder containing a piston which drives an offset cam attached to the pivot of the stripping arm assembly in order to impart controlled forward and return rotary motion to the
25 stripping knives.

 7. Apparatus according to claim 1, wherein the cathodes are provided with a dielectric area at the upper portion of the side edge where the blades of the stripping

knives initially come into contact with the cathode during the stripping operation, and wherein said blades are designed to have a curvature which matches the profile of the dielectric area where said blades wedge between the cathode base plate and the zinc sheets on each side of the cathode.

8. Apparatus according to claim 1, wherein the means for automatically moving, stopping and positioning the carriage framework, with the stripping arm assembly thereby being successively aligned with each cathode to be stripped, comprises an electrically driven, linear actuator drive controlled by a programmable logic controller.

9. Apparatus according to claim 1, wherein the means for automatically pivoting the stripping arm assembly and continuing the pivoting movement until the zinc sheets are separated from the cathode base plate are hydraulically operated and controlled by a programmable logic controller.

10. Apparatus according to claim 1, wherein the carriage framework also comprises an anti-sway arm which operates so as to contact and hold in place the cathode next ahead of the cathode actually being stripped, thereby preventing its sway by falling zinc sheet and avoiding a positioning error of the stripping arm assembly.

11. Apparatus according to claim 1, 5, 6 or 9, wherein the stripping knives are programmed by a programmable logic controller to spread apart, away from the cathode base plate, after penetration between said cathode base plate and the zinc sheets, thereby pushing the zinc sheets outwardly and facilitating their stripping.

12. Apparatus according to claim 1, wherein the carriage framework also comprises a washing device for washing the cathodes just ahead of the one being stripped and the cathode base plates just behind the cathode being
5 stripped.

13. Apparatus according to claim 12, in which said washing device comprises jet spray heads mounted on individual extensible rods which are located just above the top ends of the zinc sheets on the cathode and which are
10 long enough to reach the full length of the cathode and means for advancing and retracting the heads horizontally across the width of the cathode, said heads being so situated on the carriage framework that, when extended, they penetrate between two cathodes which are located just ahead
15 of the cathode being stripped and between two cathode base plates which are located just behind the cathode being stripped, and means are provided to supply water under pressure into said jet spray-heads so as to perform washing of said cathodes and cathode base plates.

20 14. Apparatus as claimed in any one of claims 1 to 13, which is supported and moved about by means of at least four wheels, at least two of which are steerable, thereby rendering said apparatus mobile.

25 15. Apparatus according to any one of claims 1 to 14, wherein the means in the bottom area of the supporting frame for removing fallen zinc sheets include a conveyor which conveys said zinc sheets out of the apparatus and

onto a stacking conveyor which stacks said zinc sheets on a continuous basis on a further load-out conveyor which moves stacks of zinc sheets to a receiving bin.

16. A method for automated stripping of
5 electrodeposited zinc sheets from aluminum cathode base plates comprising:

(a) suspending on an elongated supporting frame a plurality of cathodes so that they hang vertically in parallel alignment with one another, said cathodes
10 comprising the aluminum cathode base plates with zinc sheets electrodeposited on each side thereof;

(b) providing a stripping mechanism comprising a carriage framework mounted on a side of said elongated supporting frame, said carriage framework being movable
15 along a lateral line beside said elongated supporting frame, said stripping mechanism also comprising a single stripping arm assembly carried by said carriage framework and having a pair of guide arms separated by a gap of sufficient width to allow each cathode base plate to penetrate into said gap
20 and having, at the outer free ends of said guide arms, a pair of stripping knives with blades capable of wedging between said cathode base plate and said zinc sheets deposited on each side thereof, when said stripping arm assembly is swung towards and meets a side edge of said
25 cathode;

(c) moving said carriage framework linearly along said lateral line and automatically stopping and

positioning the single stripping arm assembly at each successive cathode so that it is aligned successively with each cathode;

5 (d) upon such positioning, automatically pivoting said stripping arm assembly towards an upper portion of the side edge of the cathode so that the blades of the stripping knives wedge between the cathode base plate and the zinc sheets on each side of the cathode when they come in contact with said side edge;

10 (e) stripping said zinc sheets from said cathode base plate by continuing the pivoting movement of said stripping arm assembly with the cathode base plate penetrating into the gap between the guide arms until the zinc sheets are separated from said cathode base plate, and then returning
15 said stripping arm assembly to its original position; and

(f) automatically continuing the stripping operation until substantially each cathode suspended on said elongated supporting frame has been so stripped.

17. Method according to claim 16, wherein the
20 automatic stopping, positioning and pivoting of the stripping arm assembly is carried out by a programmable logic controller provided with a panel for the required automatic operations.

18. Method according to claim 17, wherein one of the
25 automatic operations allows to pivot the stripping arm assembly a predetermined number of times in succession if the first time does not strip the zinc sheets from a given cathode.

19. Method according to claim 18, wherein another automatic operation allows the stripping arm assembly to move on to the next cathode if the zinc sheets are not stripped from the given cathode after a predetermined number of attempts.

20. Method according to claim 16, wherein the edges of the cathodes where the blades of the stripping knives wedge between the cathode base plate and the electrodeposited zinc sheets is provided with a dielectric area to facilitate such wedging.

21. Method according to claim 20, wherein said dielectric area is provided at the edge of the cathode base plate which is at solution line level during electrodeposition of zinc.

22. Method according to claim 20 or 21, wherein in addition to said dielectric area, the cathode base plates are provided with dielectric edge-strips so as to prevent electrodeposition of zinc at such edges.

23. Method according to claim 20 or 21, wherein the blades of the stripping knives have a curvature that matches the dielectric area profile at the place where said blades wedge between the cathode base plate and the zinc sheets.

24. Method according to claim 20, 21, 22 or 23, wherein the pivoting of the stripping arm assembly is carried out with a radius of rotation such that the blades of the stripping knives correctly strike the dielectric area on each side of the cathode and continue in a downward

arc s as to intersect the central area of the cathode base plate, such that each guide arm passes on the opposite side of the cathode base plate being stripped without touching said base plate.

5 25. Method according to claim 24, wherein as they continue in a downward arc, the stripping knives are automatically spread apart to facilitate the stripping operation.

10 26. Method according to any one of claims 16 to 25, wherein the cathodes are spray-washed prior to stripping of the zinc sheets and the cathode base plates are spray-washed after stripping of the zinc sheets.

15 27. Method according to any one of claims 16 to 26, wherein, after stripping, the zinc sheets fall by gravity onto a bottom conveyor and are conveyed therefrom to be stacked and transported to a storage area.

ABSTRACT OF THE DISCLOSURE

This invention concerns a method and an apparatus for automated stripping of electrodeposited zinc sheets from aluminum cathode base plates. This is achieved using a stripping mechanism that has a single pivotable stripping arm assembly linearly movable on the side of a rack of cathodes suspended vertically in parallel alignment with one another. The single stripping arm assembly is automatically moved and positioned in alignment with each cathode and then pivoted so that the knives mounted at the end of the stripping arm assembly wedge between the cathode base plate and the zinc sheets on each side of the cathode and then proceed to peel or strip the zinc sheets from the cathode base plate. This is done until each cathode is so stripped. The apparatus is preferably provided with wheels for mobility.

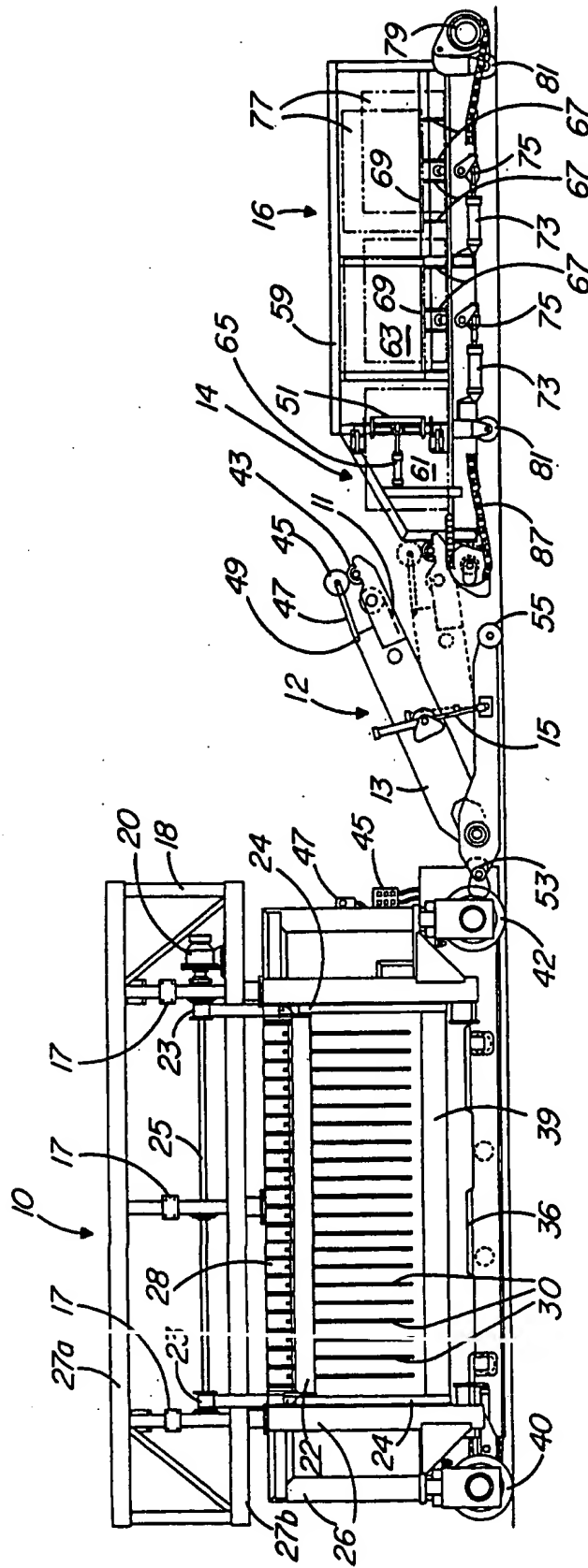


Fig. 1

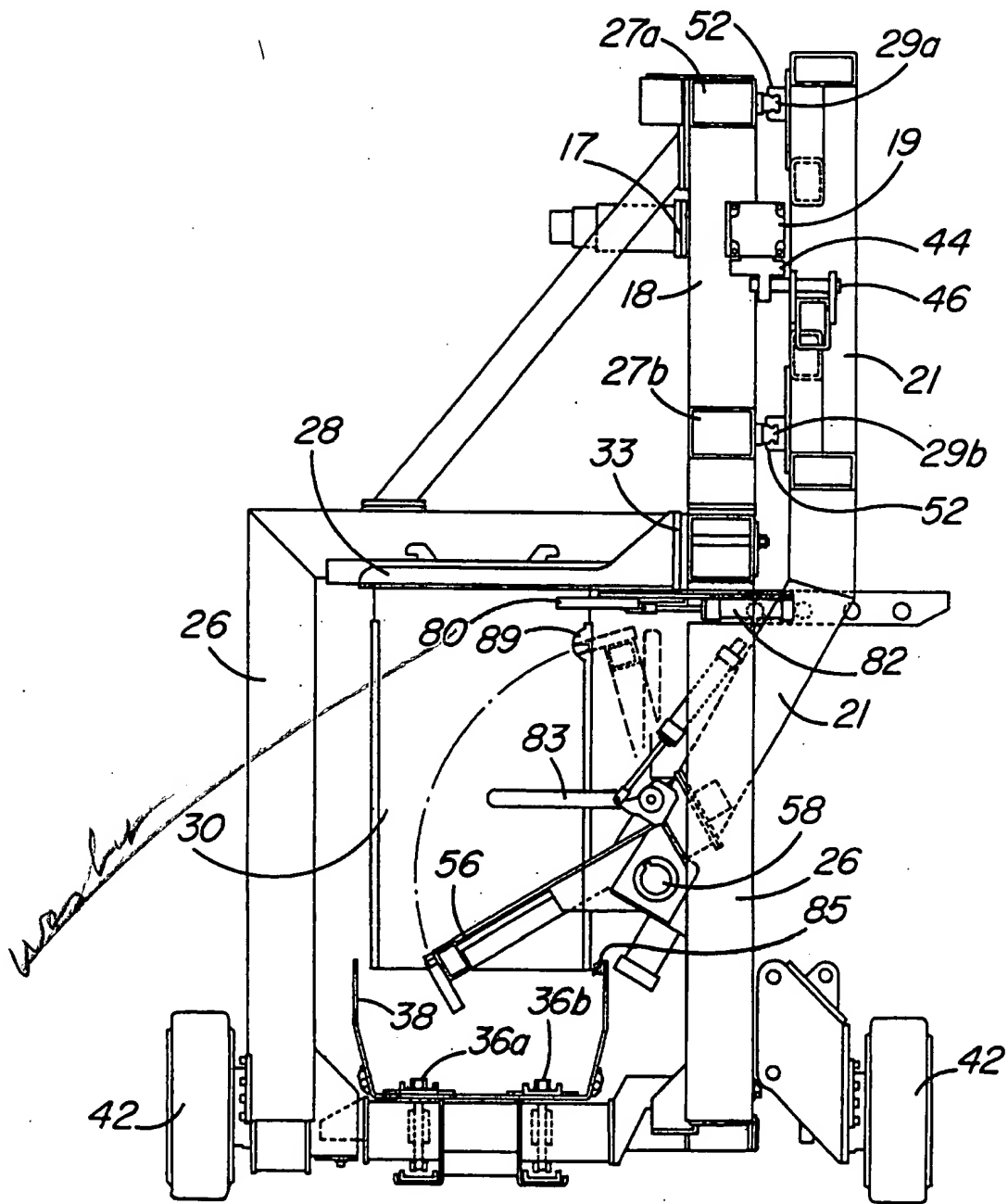


Fig. 2

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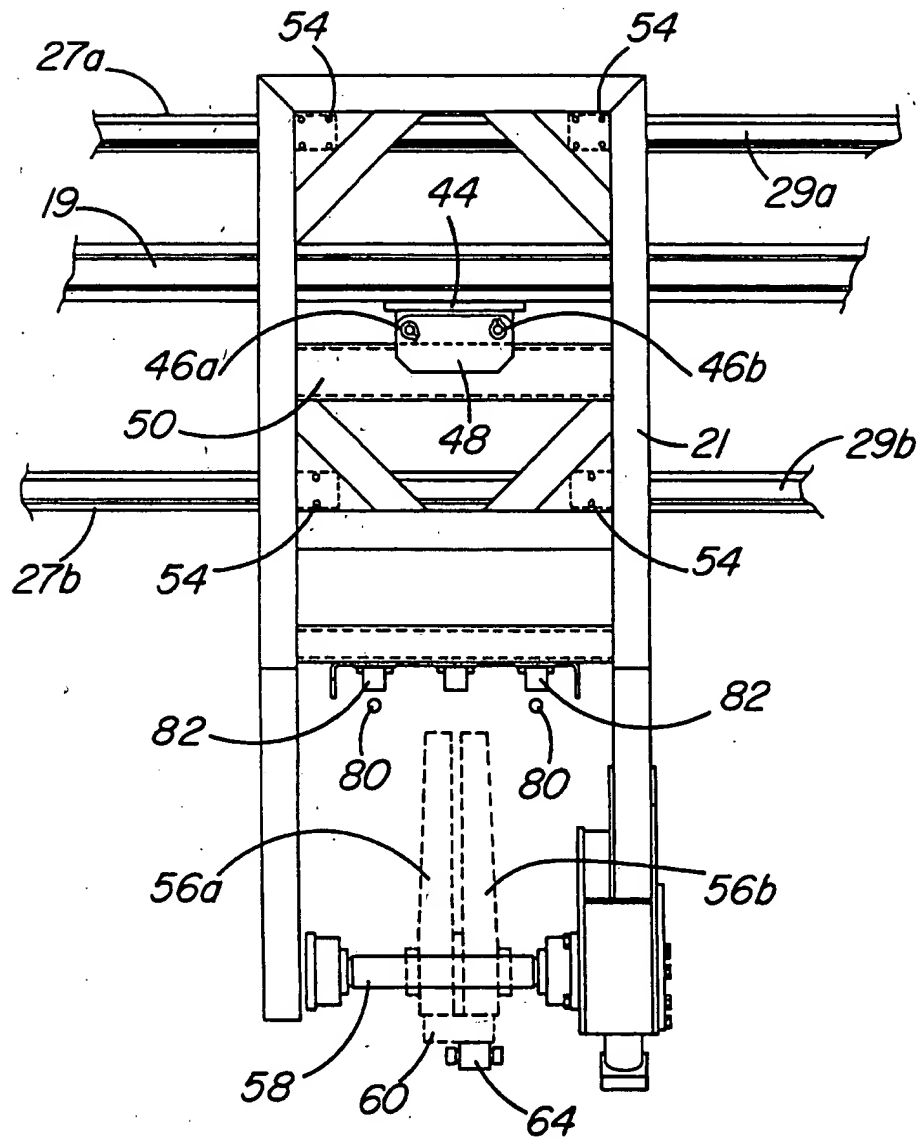


Fig. 3

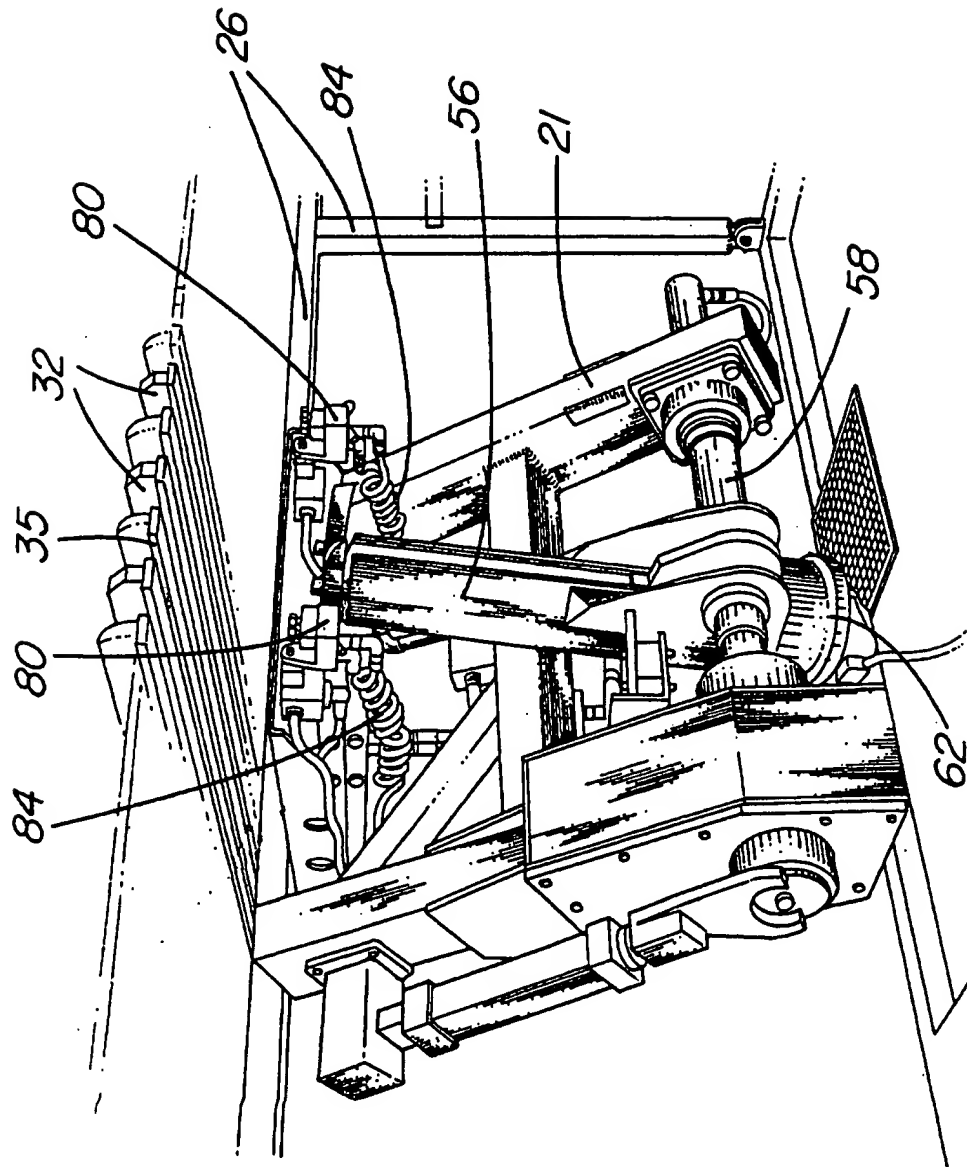
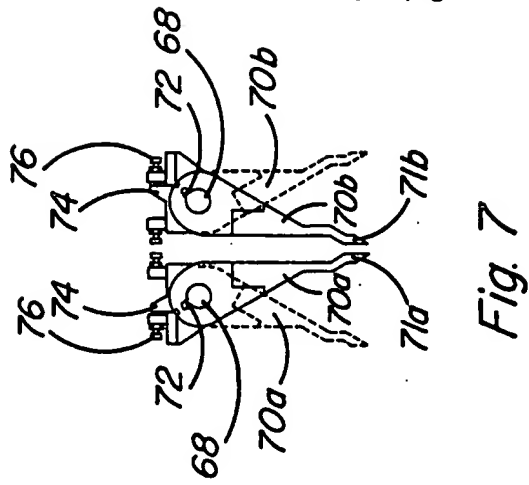
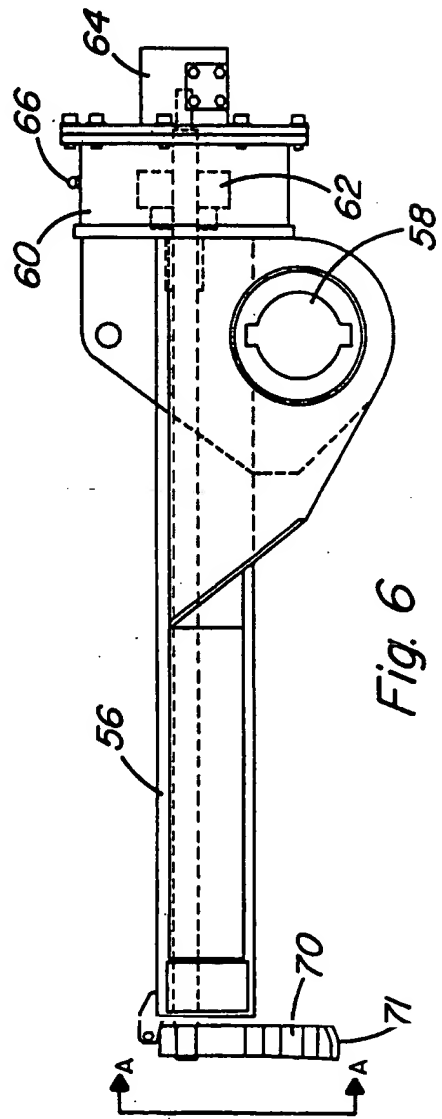
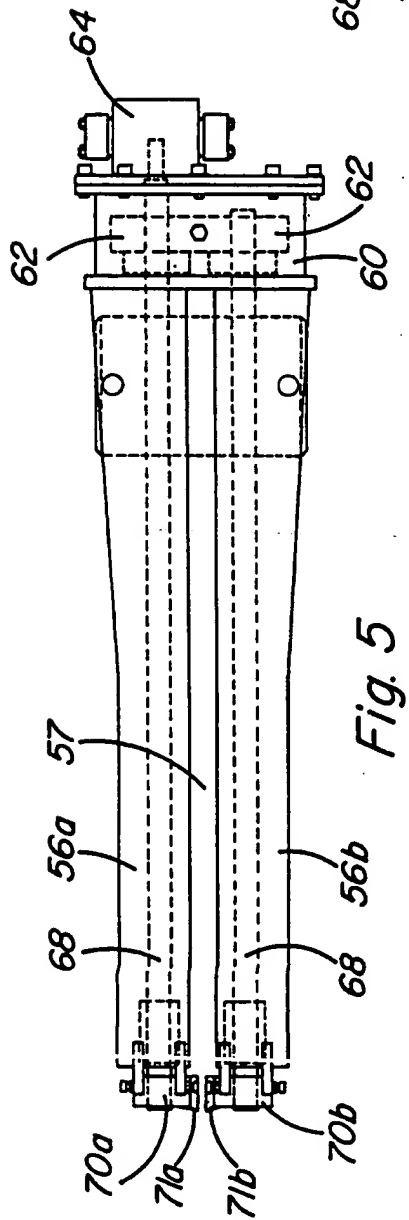


Fig. 4



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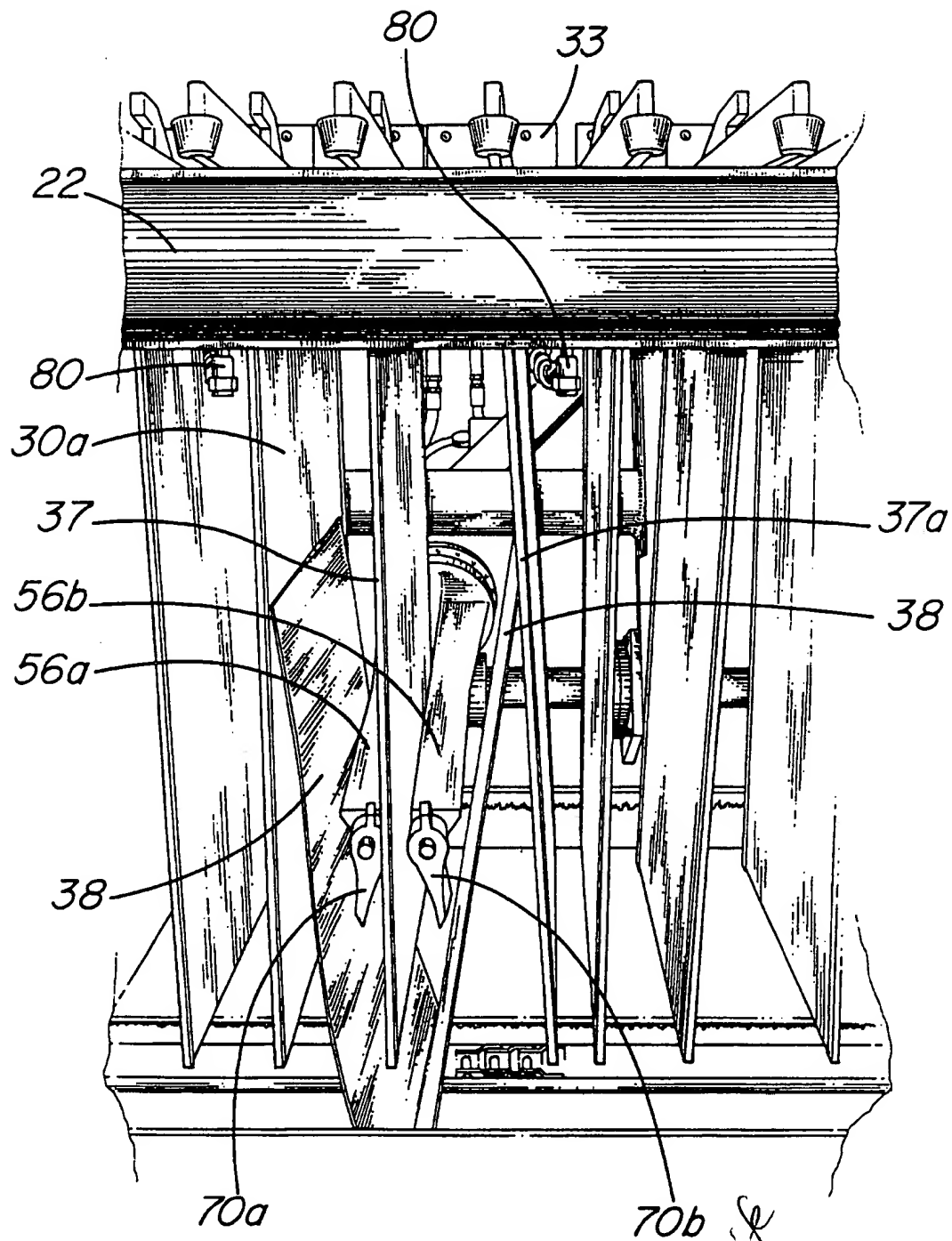


Fig. 8

Knife

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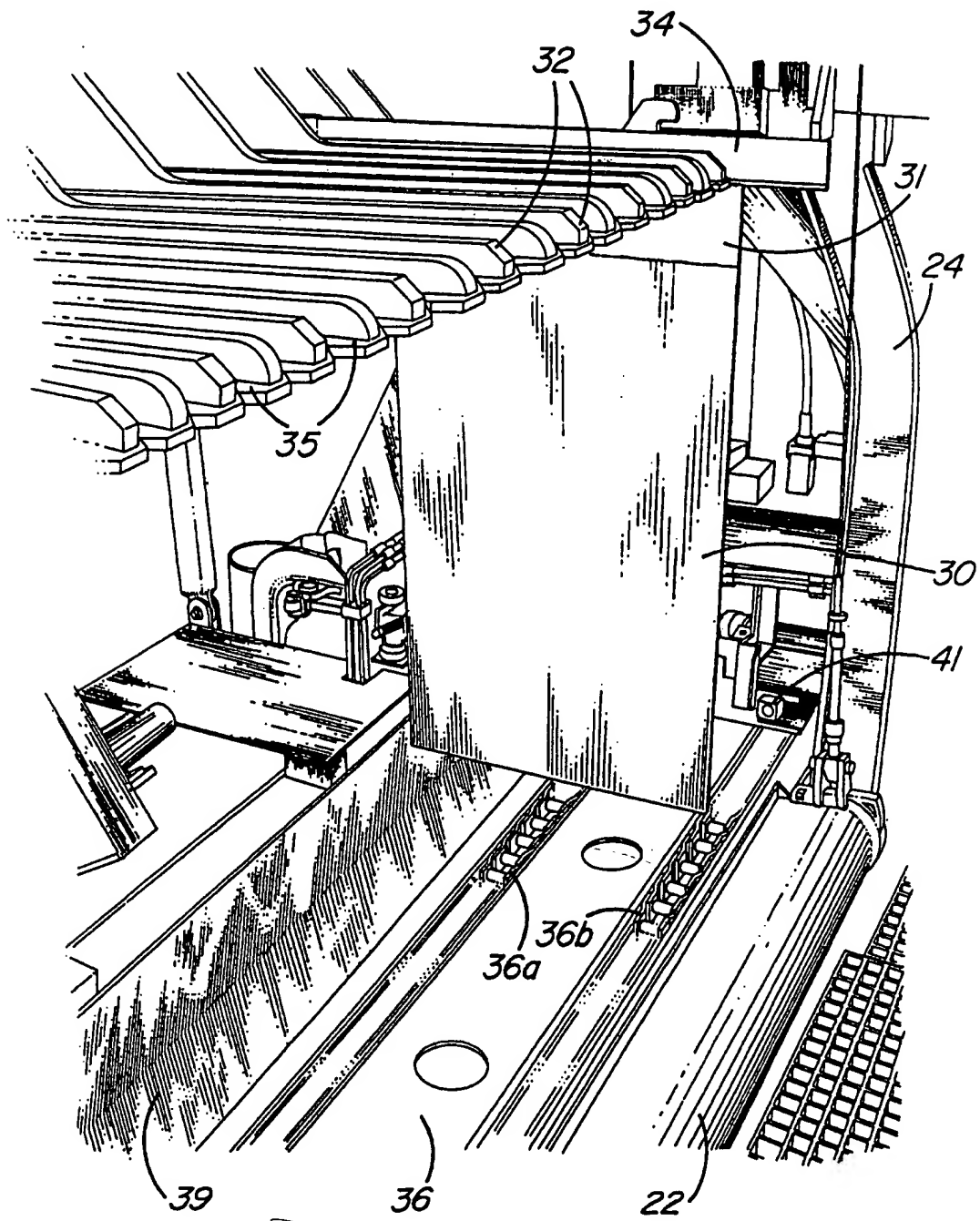
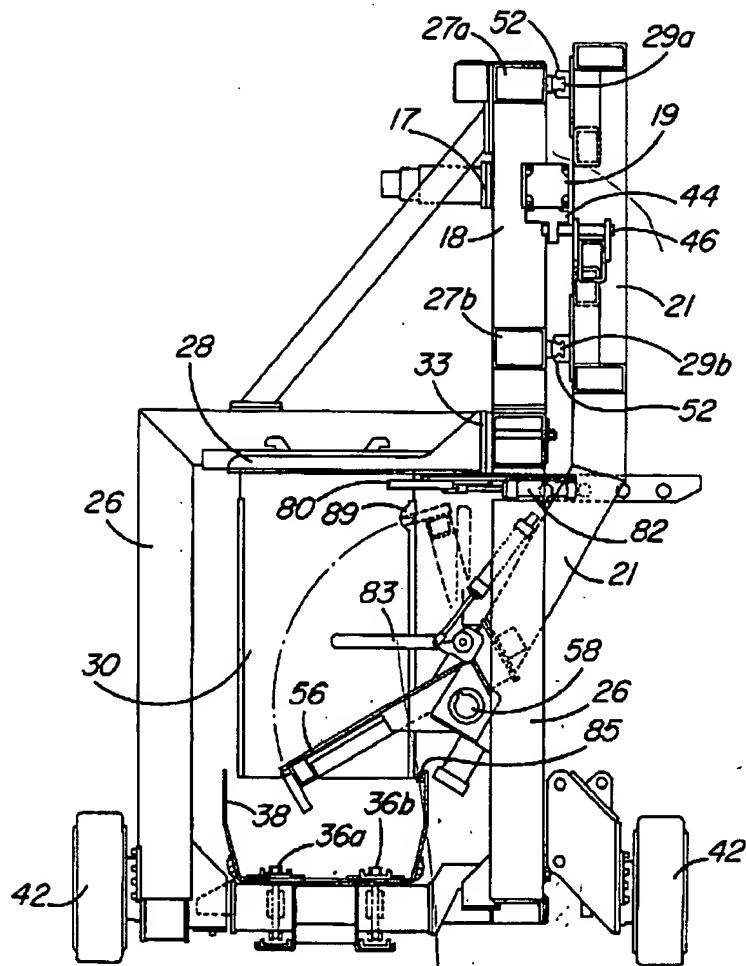
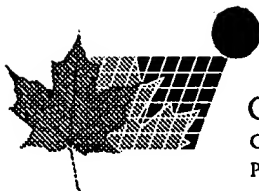


Fig. 9



*Main frame
to have let new of
Cot. 1/2*



(11) (21) (C) **2,178,776**

(22) 1996/06/11

(43) 1997/12/12

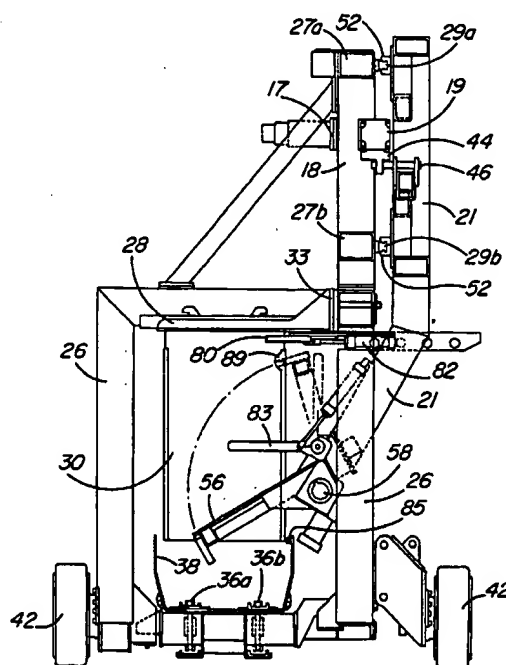
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(54) **PROCEDE ET DISPOSITIF DE DECOLLAGE AUTOMATIQUE
DE FEUILLES DE ZINC FORMEES PAR
ELECTRODEPOSITION SUR DES PLAQUES CATHODIQUES
EN ALUMINIUM**

(54) **METHOD AND APPARATUS FOR AUTOMATED STRIPPING
OF ZINC SHEETS FROM ALUMINUM CATHODE BASE
PLATES**



(57) La présente invention a trait à un procédé et un dispositif de décollage automatiques des feuilles de zinc à partir de plaques de base de cathodes d'aluminium. Cela est réalisé en utilisant un mécanisme de décollage doté d'un ensemble de bras de décollage à pivot

(57) This invention concerns a method and an apparatus for automated stripping of electrodeposited zinc sheets from aluminum cathode base plates. This is achieved using a stripping mechanism that has a single pivotable stripping arm assembly linearly movable on the side of a

